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Process for the Direct Foam-Backing of Absorber Systems

The present invention relates to a process for the preparation of mass-absorber systems, sound insulations with a high heat-deflection temperature and a high noise-reducing effect, especially for the engine compartment of motor vehicles.

In the engine compartment of motor vehicles, absorber only, mass-absorber, spring-mass systems as well as vibration-damping systems, heat shields with an absorptive effect and Helmholtz resonators are employed for noise reduction.

General reference may be made to DE 198 21 532 A, DE 197 26 965 A, DE 197 34 913 A, DE 199 09 046 A, WO 02/09977, DE 197 39 778 A and WO 01/12470 as well as DE 299 15 429 U.

One-layer and multilayer absorbers made of non-woven materials and/or open-pore foam materials with or without a heavy layer, frequently also with a sandwich structure, are known from the prior art.

Today, spring-mass systems are predominantly deep-drawn or extruded heavy sheets foam-backed with PUR flexible foam, as well as highly filled foam materials (compact polyurethane foams, prepared by reaction injection molding or RIM). The resistance to media can be increased by skin-coating the PUR flexible foam with a plastic film, a spray-skin agent or by in-mold coating.

Usually, mass-absorber systems consist of a non-woven material or high-expansion and die-cut foams, often in combination with melamine resin foams skin-coated in cover non-wovens or sound-transmitting sheets, and a heavy sheet. The non-woven materials and foams themselves can in turn have multilayer

structures. The heavy sheet is mostly a copolymer sheet, a highly filled (compact polyurethane (RIM) material or) foam material, or an injection-molded part.

The preparation process consists of the process steps of:

- compression-molding the absorber;
- preparing the heavy sheet or mass (deep-drawing, extrusion, foaming in reaction injection molding (RIM), injection molding);
- joining the absorber and mass; and
- die-cutting the shape.

Methods in which the absorber and flexible heavy sheet are compressed in a one-step or two-step process are also known.

However, today, the absorber and mass are bonded together predominantly by adhesive bonding, clipping or welding production technologies.

Adhesive bonding includes the partial or whole-surface application of the adhesive. This requires, on the one hand, cleaning of the mass sheet, for example, by washing or sand-blasting, to obtain a sufficiently good bonding between the mass sheet and absorber, and on the other hand an additional process step, the joining of the absorber and mass. In practice, it is often seen that the bonding is not sufficiently stable. Also, adhesive bonding is a tedious process in which adhesive residues often contaminate the installations, tools and workplace.

The clipping and welding, also as an additional process step, is done partially and thus not always ensures the dimension and sound insulating function of a mass-absorber system. When the motor vehicle is driven, clipped systems result in undesired noise due to currents of air between the layers, and clipped and welded systems exhibit tearing and tear propagation in the absorber and heavy sheet.

In addition, welding is very cost-intensive because of expensive apparatus, and not all combinations of materials can be welded properly (in a function-adapted way).

It is further known that non-woven materials with thermoplastic and thermoset bonding, preferably cotton mixed fiber non-wovens, are equipped with barrier (heavy) layers applied by spraying, knife-coating, extrusion or film-coating, also in a sandwich structure.

Further, it is known from the prior art that compression-molded non-woven materials with thermoplastic and thermoset bonding can be directly foam-backed because they have a high intrinsic strength (compression strength), and thus the absorber structure can hardly be destroyed, or not at all so, by pressure.

In the (thermal) compression molding of absorbers having a multilayer structure and consisting of one or more cover layers, support layers and absorber layers, it is known from the prior art that pressurized air is introduced into the mold through pressurized air ducts during compression molding. This serves the purpose, inter alia, of a better mold filling, of a positive connection between the individual layers, and of complete curing. Also, an improvement of acoustic effectiveness can be achieved by applying (air-tight) separation or barrier sheets/layers between the individual layers, especially between the absorber layers; see DE 197 34 913 A.

The direct foam-backing of high-expansion foam absorbers with foam materials, especially with highly filled compact, optionally microcellular, polyurethane (RIM) materials or foam materials could not be realized to date, because the pressure built within the foaming mold crushes or destroys the high-expansion foam (absorber) structure, and thus the acoustic effectiveness, dimension and function of the absorber are no longer obtained. Also, the thickness tolerance of the mass, which is predefined for acoustic and constructive reasons, is not observed.

Also, foaming into an open mold, i.e., inserting the absorber into the foaming mold, free foaming onto the absorber and then closing the mold, cannot be realized, because the filling of the contours by the foam is not ensured because of

the reactivity (thermo-rheokinetics) and the related flowability of the foam, and thus the mass-absorber system is unusable.

Also, the spray application of highly filled PUR compact systems cannot, or only with great problems, be realized in large series due to the very high abrasion of the systems. This requires a continuous maintenance of the installations and tools, which is very expensive. In addition, the predefined mass-thickness tolerances to be observed cannot be observed in a process-suitable way due to the spray application.

It is the object of the invention to provide a process which is applicable to industrial processes and which allows the direct foam-backing of a (high-expansion) foam absorber or non-woven absorber with highly filled (compact polyurethane (RIM)) foam materials.

According to the invention, this object is achieved by skin-coating the absorber with a foam-impermeable non-woven material or a foam-impermeable plastic sheet on the mass side, and not or with a sound-transmitting and thus air-permeable non-woven material on the side facing away from the mass, positioning said absorber within the foaming mold, closing the foaming mold, and applying pressurized air to the absorber through the air-permeable non-woven material or directly, followed by initiating the foaming process.

In the following, the process according to the invention is presented by using a typical mass-absorber system as employed in the engine compartment of motor vehicles as an example.

The process according to the invention is capable of overcoming the drawbacks of the mass and absorber bonding/joining options practiced today as stated in the prior art, of improving the preparation methods and functionality, and of dispensing with the joining process step altogether.

Thus, a first embodiment of the present invention relates to processes for the direct foam-backing of absorber systems in which the absorber consists of a foam

layer or non-woven layer with a cover layer on one or both sides, characterized in that an absorber with a very low density is provided with a foam-impermeable cover layer on the mass side, the absorber is positioned within the foaming mold, and a pressure is built within the absorber from the side facing away from the mass in the closed foaming mold, before the foaming process is initiated.

In a further embodiment, the process is characterized in that a medium in a gaseous state of matter, especially (pressurized) air, is employed as a pressure-applying medium, and a pressure of from 0.5 bar to 7 bar, especially from 1 bar to 3 bar, is built within the absorber by means of a medium in a gaseous state of matter.

In a preferred embodiment, a non-woven material or a plastic sheet is employed as the foam-impermeable cover layer on the mass side.

In a further embodiment, an open-pore or mixed-cell foam with a density of foam of from  $5 \text{ kg/m}^3$  to  $38 \text{ kg/m}^3$  is employed as the absorber.

Preferably, in a further embodiment, a foam-molded cold foam with a density of foam of from  $35 \text{ kg/m}^3$  to  $190 \text{ kg/m}^3$  is employed as the absorber. On the mass side, these absorbers are provided with a foam-impermeable cover layer.

In a further embodiment, a non-compressed non-woven material with a foam-impermeable cover layer on the mass side is employed as the absorber.

The pressure to be built before the foam-backing process is controlled, for example, by valves. The pressure to be built before the foam-backing process is optionally defined, controlled and thus adjusted by valves during the whole foaming process.

In a further embodiment, the process is characterized in that the pressure to be built within the absorber before the foam-backing process, which is controllable during the whole foaming process, is controlled and thus adjusted from the side facing away from the mass within the foaming mold with a partially different

intensity by a segment construction of the foaming mold part facing away from the mass.

A further embodiment of the invention consists of an absorber system in which the absorber consists of a foam layer or non-woven layer with a cover layer on one or both sides and a foam layer.

Preferably, according to the present invention, the foaming die should have an air nozzle distance of 100 mm above the mold surface, to be directed towards the absorber surface facing away from the mass, and the absorber should be pressurized with an air pressure of 2 bar through the air-permeable non-woven or directly when the foaming mold is closed.

Depending on the set-up and structure of the absorber, the deformation stability of the absorber can be adjusted through the arrangement of the air nozzles in the foaming die and the air pressure applied.

Figure 1 shows a sound insulation of an outer transmission tunnel 1 as a mass-absorber system in which the high-expansion foam absorber 2 is skin-coated with a foam-impermeable non-woven 3 on the mass side and with an air-permeable non-woven 4 on the side facing away from the mass. With the process according to the invention, an absorber can be directly foam-backed with a highly filled (compact polyurethane (RIM)) foam 5.

Particularly preferred sound insulations, mass-absorber systems which can be prepared with the process according to the invention are the outer tunnel, the front wall of the engine compartment, and the front wall of the aggregate compartment.

Example:

A high-expansion foam absorber was prepared in a compression molding process with the material structure: foam-impermeable non-woven (on the mass side) Azetin® GPV MH 50/45 PE, high-expansion foam with a density of foam of

12 kg/m<sup>3</sup> and a thickness of 18 mm, air-permeable non-woven (on the side facing away from the mass) Coatilphoob® Z21PE.

This absorber was inserted into the foaming (foam-backing) mold, and the mold was closed. Through the die which was equipped with air nozzles, the absorber was provided with pressurized air through the air-permeable non-woven, and then the foaming process was initiated with a commercially available compact (RIM) foam. After the foaming process was complete, the contours were punched out.

#### Directly foam-backed absorber

The directly foam-backed mass has a thickness of  $3.0 \pm 0.5$  mm over the surface. The bonding between the mass and absorber is extremely strong and stable. A separation of the mass and absorber can be effected only with destruction of the absorber. Thus, the dimension and functionality for the mass-absorber system are obtained.